NEET-UG Biology Sample Paper - 15

Duration: 1 Hour **Maximum Marks: 360**

Instructions

- This paper contains a total of 90 Multiple Choice Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Q1. If a template strand of DNA has the sequence 3'-TACGTACGT-5', what will be the sequence of the mRNA transcribed and the coding strand of DNA respectively?

(A) 5'-AUGCUAGCA-3' and 5'-ATGCATGCA-3'

(B) 5'-AUGCAUGCA-3' and 5'-ATGCATGCA-3'

(C) 5'-UACGUACGU-3' and 5'-TGCATGCAT-3'

(D) 3'-AUGCAUGCA-5' and 5'-ATGCATGCA-3'

Q2. In a cross between a white-eyed female fruit fly and a red-eyed male, what percentage of the female offspring will have white eyes? (Assume X-linked inheritance).

(A) 0%

(B) 25%

(C) 50%

(D) 100%

Q3. Which of the following statements regarding the "Lac Operon" is incorrect?

(A) Glucose or galactose may bind with the repressor and inactivate it.

(B) In the absence of lactose, the repressor binds to the operator region.

(C) The z gene codes for β-galactosidase.

(D) It is an inducible operon.

Q4. A pedigree analysis shows a trait that skips generations and affects males and females equally. What is the most likely mode of inheritance?

(A) Autosomal Dominant

(B) Autosomal Recessive

(C) X-linked Dominant

(D) Y-linked

Q5. During the cardiac cycle, the "Lubb" sound is produced by:

(A) Closure of the semilunar valves.

(B) Closure of the AV (tricuspid and bicuspid) valves.

(C) Opening of the semilunar valves.

(D) Blood rushing into the ventricles.

Q6. Which part of the brain is responsible for thermoregulation and also contains centers for hunger and thirst?

(A) Cerebellum

(B) Medulla oblongata

(C) Hypothalamus

(D) Corpus callosum

Q7. Identify the correct sequence of events in a nerve impulse:

(A) Polarization $\rightarrow$ Depolarization $\rightarrow$ Repolarization

(B) Depolarization $\rightarrow$ Polarization $\rightarrow$ Repolarization

(C) Repolarization → Depolarization → Polarization

(D) Polarization → Repolarization → Depolarization

Q8. In the sliding filament theory of muscle contraction, the Ca^{2+} ions bind to which protein to reveal myosin-binding sites?

(A) Tropomyosin

(B) Troponin

(C) Actin

(D) Myosin light chain

Q9. Which of the following cell organelles is double membrane-bound and contains its own DNA and 70S ribosomes?

(A) Lysosome

(B) Chloroplast

(C) Golgi apparatus

(D) Endoplasmic Reticulum

Q10. The "Fluid Mosaic Model" of the cell membrane suggests that:

(A) Proteins are a continuous layer.

(B) Lipids are a sandwich between proteins.

(C) Proteins are embedded in a fluid phospholipid bilayer.

(D) Carbohydrates form the inner core.

Q11. Synapsis occurs between:

(A) Two non-homologous chromosomes.

(B) A male and a female gamete.

(C) Two homologous chromosomes.

(D) Spindle fibers and centromeres.

Q12. The phase of the cell cycle where the cell is metabolically active but no longer divides unless called upon is:

(A) G_1 phase

(B) G_2 phase

(C) G_0 phase

(D) S phase

Q13. Which enzyme is used to join DNA fragments?

(A) DNA Polymerase

(B) DNA Ligase

(C) Helicase

(D) Endonuclease

Q14. In Miller's experiment, which gases were used to simulate the primitive atmosphere?

(A) CH_4, NH_3, H_2, H_2O

(B) CO_2, N_2, O_2, H_2O

(C) CH_4, O_2, N_2, H_2O

(D) NH_3, H_2, O_2, CO_2

Q15. The 'Vital Capacity' of the human lung is equal to:

(A) $TV + IRV$

(B) $TV + ERV$

(C) $TV + IRV + ERV$

(D) $IRV + ERV$

Q16. Which hormone is called the "emergency hormone"?

(A) Insulin

(B) Thyroxine

(C) Epinephrine

(D) Estrogen

Q17. The basic functional unit of the human kidney is:

(A) Nephron

(B) Neuron

(C) Henle's Loop

(D) Glomerulus

Q18. Which of the following is a primary lymphoid organ?

(A) Spleen

(B) Tonsils

(C) Bone Marrow

(D) Peyer's patches

Q19. The enzyme 'Enterokinase' helps in the conversion of:

(A) Casein to Paracasein

(B) Proteins to Polypeptides

(C) Trypsinogen to Trypsin

(D) Pepsinogen to Pepsin

Q20. The process of 'Splicing' in eukaryotes involves the removal of:

(A) Exons

(B) Introns

(C) Promoter

(D) Terminator

Q21. In a population, if the frequency of recessive allele 'q' is 0.4, what is the frequency of the homozygous dominant genotype (AA)?

(A) 0.16

(B) 0.36

(C) 0.48

(D) 0.60

Q22. Which of the following is an example of 'Adaptive Radiation'?

(A) Darwin's Finches

(B) Australian Marsupials

(C) Both A and B

(D) None of the above

Q23. The hormone 'Relaxin' is secreted by:

(A) Corpus luteum

(B) Pituitary

(C) Adrenal gland

(D) Thyroid

Q24. During DNA fingerprinting, the separation of DNA fragments is done by:

(A) Centrifugation

(B) Electrophoresis

(C) PCR

(D) Southern Blotting

Q25. Which of the following is NOT a feature of the Genetic Code?

(A) Universal

(B) Degenerate

(C) Ambiguous

(D) Non-overlapping

Q26. The 'Statins' used for lowering blood cholesterol are extracted from:

(A) *Monascus purpureus*

(B) *Trichoderma polysporum*

(C) *Saccharomyces cerevisiae*

(D) *Aspergillus niger*

Q27. Which stage of cell division is characterized by the alignment of chromosomes at the equatorial plate?

(A) Prophase

(B) Metaphase

(C) Anaphase

(D) Telophase

Q28. Which of the following is a vestigial organ in humans?

(A) Nictitating membrane

(B) Ear muscles

(C) Vermiform appendix

(D) All of the above

Q29. The process of "Capacitation" occurs in:

(A) Epididymis

(B) Vas deferens

(C) Female reproductive tract

(D) Rete testis

Q30. Which of the following is a non-reducing sugar?

(A) Glucose

(B) Fructose

(C) Sucrose

(D) Lactose

Q31. In C_4 plants, the first stable product of CO_2 fixation is:

(A) PGA

(B) OAA

(C) RuBP

(D) PEP

Q32. The synthesis of ATP by the chemiosmotic mechanism requires:

(A) Proton gradient

(B) Electron gradient

(C) Glucose gradient

(D) Oxygen gradient

Q33. Which hormone is responsible for 'Bolting' in plants?

(A) Auxin

(B) Gibberellin

(C) Cytokinin

(D) Ethylene

Q34. The technique 'GIFT' (Gamete Intra Fallopian Transfer) is recommended for females:

(A) Who cannot produce an ovum.

(B) Who cannot provide a suitable environment for fertilization.

(C) Who have blocked fallopian tubes.

(D) Who are unable to conceive due to low sperm count in partner.

Q35. A restriction enzyme cuts DNA at a specific sequence called:

(A) Palindromic sequence

(B) Repeating sequence

(C) Random sequence

(D) Start codon

Q36. In 'Bt Cotton', the Bt toxin kills the insects by:

(A) Blocking the nervous system.

(B) Creating pores in the midgut epithelial cells.

(C) Inhibiting protein synthesis.

(D) Preventing DNA replication.

Q37. Double fertilization is a characteristic feature of:

(A) Gymnosperms

(B) Angiosperms

(C) Pteridophytes

(D) Bryophytes

Q38. The 'Ti plasmid' used in plant genetic engineering is obtained from:

(A) *Agrobacterium tumefaciens*

(B) *Bacillus thuringiensis*

(C) *Escherichia coli*

(D) *Salmonella typhimurium*

Q39. Which of the following is a method of 'Ex-situ' conservation?

(A) National Park

(B) Wildlife Sanctuary

(C) Seed Bank

(D) Biosphere Reserve

Q40. The water potential of pure water at standard temperature is:

(A) 0

(B) 100

(C) -10

(D) 1

Q41. Which enzyme catalyzes the nitrogen fixation in root nodules?

(A) Nitrogenase

(B) Hydrogenase

(C) Nitrate reductase

(D) Nitrite reductase

Q42. The movement of water through the cell wall and intercellular spaces is called:

(A) Symplast

(B) Apoplast

(C) Osmosis

(D) Active transport

Q43. Which of the following is a "stop codon"?

(A) AUG

(B) UAA

(C) UGG

(D) GUG

Q44. The transgenic cow 'Rosie' produced milk enriched with:

(A) Human α-lactalbumin

(B) Vitamin A

(C) Insulin

(D) Growth hormone

Q45. 'Cry' genes are obtained from:

(A) *Bacillus thuringiensis*

(B) *Rhizobium*

(C) *Agrobacterium*

(D) *E. coli*

Q46. The part of the flower that develops into a fruit is:

(A) Ovule

(B) Ovary

(C) Anther

(D) Stigma

Q47. Pollination by wind is called:

(A) Anemophily

(B) Hydrophily

(C) Entomophily

(D) Ornithophily

Q48. The formation of a megaspore from a megaspore mother cell is called:

(A) Megasporogenesis

(B) Microsporogenesis

(C) Pollination

(D) Fertilization

Q49. Which of the following is a secondary metabolite?

(A) Glucose

(B) Amino acids

(C) Alkaloids

(D) Fats

Q50. The substrate for photorespiration is:

(A) Glycolate

(B) Glucose

(C) Pyruvate

(D) Acetyl CoA

Q51. Which of the following is NOT a step in PCR?

(A) Denaturation

(B) Annealing

(C) Extension

(D) Splicing

Q52. The "Montreal Protocol" is related to:

(A) Global warming

(B) Ozone depletion

(C) Biodiversity conservation

(D) Water pollution

Q53. 'Humulin' is:

(A) Human Insulin

(B) A carbohydrate

(C) A vaccine

(D) An antibiotic

Q54. The 'Polymerase Chain Reaction' (PCR) was developed by:

(A) Kary Mullis

(B) Watson and Crick

(C) Mendel

(D) Morgan

Q55. Which of the following is a physical barrier of the innate immune system?

(A) Skin

(B) Monocytes

(C) Interferons

(D) Fever

Q56. The process of "Leaching" in decomposition refers to:

(A) Breaking down of detritus into smaller particles.

(B) Water-soluble inorganic nutrients going down into the soil.

(C) Degradation of humus by microbes.

(D) Accumulation of dark-colored amorphous substance.

Q57. Which of the following is a greenhouse gas?

(A) Methane

(B) Nitrogen

(C) Oxygen

(D) Argon

Q58. The 'Lichen' is a symbiotic association between:

(A) Algae and Fungi

(B) Algae and Bacteria

(C) Fungi and Roots of higher plants

(D) Bacteria and Roots of higher plants

Q59. In an ecosystem, the flow of energy is:

(A) Unidirectional

(B) Bidirectional

(C) Multidirectional

(D) Cyclic

Q60. Which of the following is a "pioneer species" in primary succession on rocks?

(A) Mosses

(B) Lichens

(C) Ferns

(D) Grasses

Q61. The five-kingdom classification was proposed by:

(A) Linnaeus

(B) Whittaker

(C) Aristotle

(D) Haeckel

Q62. Which of the following is the "Powerhouse of the cell"?

(A) Ribosome

(B) Mitochondria

(C) Nucleus

(D) Vacuole

Q63. 'Pneumatophores' are found in:

(A) Mangrove plants

(B) Xerophytes

(C) Hydrophytes

(D) Mesophytes

Q64. The floral formula of the family Solanaceae is:

(A) $\oplus ♀♂ K_{(5)} C_{(5)} A_5 G_{(2)}$

(B) $\%\text{♀}\text{♂}K_{(5)}C_{1+2+(2)}A_{(9)+1}G_1$

(C) $\oplus\text{♀}\text{♂}P_{(3+3)}A_{3+3}G_{(3)}$

(D) $\oplus\text{♀}\text{♂}K_5C_5A_\infty G_1$

Q65. In earthworms, the 'clitellum' is present in segments:

(A) 14-16

(B) 10-12

(C) 18-20

(D) 5-7

Q66. Which of the following is a flightless bird?

(A) Ostrich

(B) Pigeon

(C) Peacock

(D) Sparrow

Q67. 'Mycorrhiza' is an example of:

(A) Parasitism

(B) Mutualism

(C) Commensalism

(D) Predation

Q68. Which of the following is a "hotspot" of biodiversity in India?

(A) Western Ghats

(B) Gangetic Plain

(C) Thar Desert

(D) Aravali Hills

Q69. The "Pyramid of Energy" is always:

(A) Upright

(B) Inverted

(C) Spindle-shaped

(D) Urn-shaped

Q70. Which of the following is a primary pollutant?

(A) CO

(B) O_3

(C) PAN

(D) H_2SO_4

Q71. The study of the interactions between organisms and their environment is:

(A) Ethology

(B) Ecology

(C) Entomology

(D) Embryology

Q72. 'Chipko Movement' was started for the protection of:

(A) Forests

(B) Wildlife

(C) Rivers

(D) Soil

Q73. Which of the following is used in the treatment of cancer?

(A) Interferons

(B) Insulin

(C) Penicillin

(D) Streptokinase

Q74. 'Malaria' is caused by:

(A) *Plasmodium*

(B) *Entamoeba*

(C) *Trypanosoma*

(D) *Leishmania*

Q75. Which of the following is a "bio-fertilizer"?

(A) *Azolla*

(B) Urea

(C) DDT

(D) BHC

Q76. The 'Sacred Groves' are especially useful in:

(A) Generating environmental awareness.

(B) Conserving rare and threatened species.

(C) Preventing soil erosion.

(D) Year-round flow of water in rivers.

Q77. 'Eutrophication' is the result of:

(A) Nutrient enrichment of water bodies.

(B) Depletion of nutrients.

(C) Acid rain.

(D) Thermal pollution.

Q78. Which of the following is a major cause of biodiversity loss?

(A) Habitat fragmentation

(B) Over-exploitation

(C) Alien species invasion

(D) All of the above

Q79. 'Biomagnification' refers to an increase in the concentration of:

(A) Toxicants at successive trophic levels.

(B) Nutrients in water bodies.

(C) Biomass in an ecosystem.

(D) Species diversity.

Q80. The 'Joint Forest Management' (JFM) concept was introduced in India in:

(A) 1980

(B) 1970

(C) 1990

(D) 1960

Q81. Which of the following is an example of an 'In-situ' conservation?

(A) Botanical Garden

(B) Zoological Park

(C) Wildlife Sanctuary

(D) Safari Park

Q82. 'BOD' stands for:

(A) Biological Oxygen Demand

(B) Biochemical Organic Density

(C) Biotic Oxygen Delivery

(D) Bacterial Oxygen Depletion

Q83. Which of the following is used as a "biological control" agent against pests?

(A) *Ladybird beetle*

(B) *Dragonfly*

(C) *Bacillus thuringiensis*

(D) All of the above

Q84. The "Greenhouse Effect" is mainly due to:

(A) CO_2

(B) O_2

(C) N_2

(D) Ar

Q85. Which of the following is the largest ecosystem of the world?

(A) Forest ecosystem

(B) Marine ecosystem

(C) Desert ecosystem

(D) Grassland ecosystem

Q86. The "Kyoto Protocol" was signed to reduce:

(A) Greenhouse gas emissions

(B) Ozone depletion

(C) Biodiversity loss

(D) Forest fire

Q87. Which of the following is an 'Endangered' species in India?

(A) Asiatic Lion

(B) Red Panda

(C) One-horned Rhino

(D) All of the above

Q88. 'Ramsar Convention' is related to:

(A) Wetland conservation

(B) Ozone protection

(C) Global warming

(D) Biodiversity

Q89. The term 'Bio-prospecting' refers to:

(A) Exploring molecular, genetic and species-level diversity for products of economic importance.

(B) Protecting biodiversity from illegal trade.

(C) Using plants for medicine.

(D) Studying the evolution of species.

Q90. The 'Red Data Book' is maintained by:

(A) IUCN

(B) WWF

(C) UNEP

(D) UNESCO

Detailed Solutions

Q1.

Solution

Concept:

The Central Dogma of Molecular Biology defines the flow of genetic information from DNA to RNA to Protein.

In transcription, RNA polymerase uses a DNA template strand to create a complementary mRNA strand.

The mRNA strand is synthesized in the $5' \rightarrow 3'$ direction, meaning it is complementary to the $3' \rightarrow 5'$ template strand and identical (except for U replacing T) to the $5' \rightarrow 3'$ coding strand.

Solution:

1. Identification of the Template:

The given template strand is 3′–TACGTACGT–5′.

2. Base Pairing for mRNA Synthesis:

According to complementarity rules:

A in DNA pairs with U in RNA.

T in DNA pairs with A in RNA.

G in DNA pairs with C in RNA.

C in DNA pairs with G in RNA.

3. Determining the mRNA Sequence:

Reading the template $3' \rightarrow 5'$, the mRNA is formed $5' \rightarrow 3'$ as:

5′–AUGCAUGCA–3′.

4. Determining the Coding Strand:

The coding strand is the non-template DNA strand ($5' \rightarrow 3'$).

It is complementary to the template:

5′–ATGCATGCA–3′.

Final Answer: The mRNA is 5′–AUGCAUGCA–3′ and the coding strand is 5′–ATGCATGCA–3′.

Answer: (B)

Q2.

Solution

Concept:

Inheritance of eye color in Drosophila is a classic example of sex-linked (X-linked) inheritance.

The gene for eye color is located on the X chromosome.

Red eye color (X^W) is dominant over white eye color (X^w).

Because males are XY, they are hemizygous and express the trait present on their single X chromosome.

Solution:

1. Assigning Parental Genotypes:

White-eyed female: X^wX^w (Must be homozygous recessive to show white eyes).

Red-eyed male: X^WY (Has the dominant allele on his only X chromosome).

2. Gamete Formation:

The female produces only one type of gamete: X^w.

The male produces two types of gametes: X^W and Y.

3. Crossing in Punnett Square:

The female offspring receive one X from the mother (X^w) and one X from the father (X^W).

Genotype of all females: X^WX^w.

Phenotype of all females: Red-eyed (due to dominance of X^W).

4. Statistical Conclusion:

Since all female offspring are heterozygous red-eyed, the percentage of white-eyed females is 0%.

Final Answer: 0% of the female offspring will have white eyes.

Answer: (A)

Q3.

Solution

Concept:

The Lac Operon is an inducible system used by E. coli to regulate the metabolism of lactose. It consists of regulatory genes (i gene), a promoter, an operator, and structural genes (z, y, a). The system is "turned on" only when lactose is present and glucose is absent.

Solution:

1. Analysis of Structural Genes:

The z gene encodes β-galactosidase, which breaks lactose into glucose and galactose. The y gene encodes permease, and the a gene encodes transacetylase.

2. The Role of the Repressor:

The i gene produces a repressor protein that constitutively binds to the operator to block transcription.

3. Function of the Inducer:

Lactose (converted to allolactose) acts as an inducer. It binds to the repressor, changing its shape so it cannot bind the operator.

4. Evaluation of the Options:

Statement A claims glucose or galactose inactivate the repressor. This is incorrect. Glucose actually inhibits the operon (Catabolite repression), and neither glucose nor galactose act as inducers for the repressor protein.

Final Answer: Statement A is incorrect because glucose and galactose do not inactivate the repressor.

Answer: (A)

Q4.

Solution

Concept:

Pedigree analysis is a tool used to determine the mode of inheritance of a genetic trait across generations.

Key rules include:

1. If a trait skips generations, it is recessive.
2. If it affects males and females equally, it is autosomal.

Solution:

1. Identifying the Recessive Nature:

In the pedigree, if unaffected parents produce an affected child, the parents must be carriers (Aa). The trait was "hidden" in the parents, confirming it is a recessive trait.

2. Identifying the Autosomal Nature:

X-linked recessive traits (like color blindness) appear much more frequently in males because they lack a second X chromosome to mask the recessive allele.

Since the trait is distributed equally among both sexes, it is not linked to sex chromosomes.

3. Synthesizing the Findings:

A trait that is both recessive and not sex-linked is classified as Autosomal Recessive.

Final Answer: The most likely mode of inheritance is Autosomal Recessive.

Answer: (B)

Q5.

Solution

Concept:

Heart sounds are produced by the closure of heart valves, which causes blood turbulence and vibration of the heart walls.

The two primary sounds are described as "Lubb" (S_1) and "Dupp" (S_2).

Solution:

1. The "Lubb" Sound (S_1):

This is the first heart sound. It is low-pitched and relatively long.

It marks the beginning of ventricular systole (contraction).

2. Mechanism of S_1:

As the ventricles contract, the pressure increases. To prevent blood from flowing back into the atria, the Atrioventricular (AV) valves—the Tricuspid and Bicuspid (mitral) valves—snap shut.

3. The "Dupp" Sound (S_2):

This is the second heart sound. It is higher pitched and shorter.

It occurs at the beginning of ventricular diastole (relaxation) when the semilunar valves (aortic and pulmonary) close to prevent backflow from the arteries into the ventricles.

Final Answer: The "Lubb" sound is produced by the closure of the AV (tricuspid and bicuspid) valves.

Answer: (B)

Q6.

Solution

Concept:

The hypothalamus is a small but vital region located at the base of the brain, below the thalamus. It acts as the body's smart control coordinating center, linking the endocrine system to the nervous system.

Its primary function is homeostasis, which involves maintaining the body's internal environment in a stable state.

Solution:

1. Thermoregulation:

The hypothalamus contains a "biological thermostat." When body temperature fluctuates, it triggers mechanisms like sweating or shivering to restore the set point.

2. Control of Hunger and Thirst:

It houses specific centers (satiety and feeding centers) that respond to nutrient levels and osmotic pressure in the blood, regulating the urge to eat and drink.

3. Comparison with other regions:

The cerebellum controls balance and posture.

The medulla oblongata regulates cardiovascular reflexes and respiration.

The corpus callosum is a fiber tract connecting the two cerebral hemispheres.

Final Answer: The hypothalamus is responsible for thermoregulation, hunger, and thirst.

Answer: (C)

Q7.

Solution

Concept:

A nerve impulse or action potential is an electrochemical signal that travels along the axon of a neuron.

This process involves the movement of ions (primarily Na^+ and K^+) across the neuronal membrane, changing its electrical potential in a specific, sequential order.

Solution:

1. Polarization (Resting State):

The membrane is at rest with a negative charge inside relative to the outside. This is maintained by the sodium-potassium pump.

2. Depolarization (Excitation):

When a stimulus reaches the threshold, voltage-gated Na^+ channels open. Na^+ rushes in, making the inside of the cell positive. This is the "action" phase.

3. Repolarization (Recovery):

Na^+ channels close and K^+ channels open. K^+ flows out of the cell, restoring the negative internal charge.

4. Conclusion:

The correct biological sequence is for a cell to move from a resting state (Polarization) to an active state (Depolarization) and then back to recovery (Repolarization).

Final Answer: The correct sequence is Polarization → Depolarization → Repolarization.

Answer: (A)

Q8.

Solution

Concept:

The sliding filament theory explains how muscles contract.

Muscles consist of thin filaments (actin) and thick filaments (myosin).

At rest, the myosin-binding sites on actin are covered by a protein complex, preventing contraction until a signal is received.

Solution:

1. Role of Calcium (Ca^{2+}):

When a nerve impulse reaches the muscle, Ca^{2+} is released from the sarcoplasmic reticulum into the sarcoplasm.

2. Binding to Troponin:

The Ca^{2+} ions bind specifically to a subunit of the troponin protein complex located on the actin filament.

3. Conformational Change:

This binding causes troponin to change its shape, which physically pulls the attached tropomyosin away from the myosin-binding sites.

4. Result:

Once the sites are exposed, the myosin heads can bind to actin, forming cross-bridges to initiate the "power stroke."

Final Answer: Ca^{2+} ions bind to Troponin to reveal myosin-binding sites.

Answer: (B)

Q9.

Solution

Concept:

According to the endosymbiotic theory, certain organelles in eukaryotic cells originated as free-living prokaryotic organisms.

These organelles possess characteristics typically found in bacteria, such as circular DNA and 70S ribosomes, which distinguish them from the rest of the eukaryotic cell (which has 80S ribosomes).

Solution:

1. Semi-autonomous Organelles:

Mitochondria and Chloroplasts are the two primary organelles that are double membrane-bound and contain their own genetic machinery.

2. Structural Analysis:

Lysosomes are single membrane-bound.

The Golgi apparatus and Endoplasmic Reticulum are part of the endomembrane system but do not contain 70S ribosomes or independent DNA.

3. Conclusion:

The chloroplast (found in plants) fits all the criteria: it has an outer and inner membrane, contains circular DNA, and possesses 70S ribosomes for protein synthesis.

Final Answer: The Chloroplast is double membrane-bound and contains 70S ribosomes and DNA.

Answer: (B)

Q10.

Solution

Concept:

The Fluid Mosaic Model, proposed by Singer and Nicolson in 1972, is the currently accepted model for the structure of the cell membrane.

It describes the membrane as a dynamic, flexible structure rather than a rigid, static one.

Solution:

1. The "Fluid" Component:

The main fabric of the membrane is a bilayer of phospholipids. These lipids are in a fluid state, allowing molecules to move laterally within the layer.

2. The "Mosaic" Component:

Proteins are dispersed throughout the lipid bilayer like tiles in a mosaic. Some are on the surface (peripheral), while others span the entire membrane (integral).

3. Significance:

This arrangement allows for selective permeability and the proper functioning of transport proteins and receptors.

4. Evaluation:

The model specifically posits that proteins are embedded in a fluid phospholipid bilayer, not that they form a continuous separate layer.

Final Answer: The model suggests that proteins are embedded in a fluid phospholipid bilayer.

Answer: (C)

Q11.

Solution

Concept:

Meiosis is a specialized form of cell division that reduces the chromosome number by half, resulting in the production of haploid gametes.

During the first prophase of meiosis (Prophase I), homologous chromosomes pair up in a highly organized process.

Solution:

1. Definition of Synapsis:

Synapsis is the physical pairing or "zipping together" of homologous chromosomes (one from the father and one from the mother).

2. When it Occurs:

This process specifically takes place during the Zygotene stage of Prophase I.

3. Formation of the Complex:

A protein structure called the synaptonemal complex forms between the paired homologous chromosomes to stabilize them, allowing for subsequent crossing over (recombination) in the Pachytene stage.

4. Clarification:

It does not occur between non-homologous chromosomes (different types) or between gametes (which occurs during fertilization).

Final Answer: Synapsis occurs between two homologous chromosomes.

Answer: (C)

Q12.

Solution

Concept:

The cell cycle consists of Interphase and M-phase. However, not all cells in a multicellular organism divide continuously.

Some cells exit the cell cycle and enter a specialized resting state where they remain functional but cease to proliferate unless specifically stimulated.

Solution:

1. The Quiescent Stage (G_0):

Cells that do not divide further exit the G_1 phase to enter an inactive stage called the G_0 phase or the quiescent stage.

2. Metabolic Activity:

Cells in G_0 are not "dormant" in a metabolic sense; they perform their specific physiological functions (e.g., nerve cells or heart muscle cells) but do not undergo DNA replication or division.

3. Re-entry:

Depending on the cell type, some can re-enter the G_1 phase and resume division in response to injury or environmental cues (like liver cells).

4. Comparison:

S phase is for DNA synthesis; G_2 is for final protein synthesis before mitosis.

Final Answer: The phase where cells are active but do not divide is the G_0 phase.

Answer: (C)

Q13.

Solution

Concept:

In genetic engineering and molecular biology, enzymes act as the "tools" for manipulating DNA. While nucleases act as "scissors" to cut DNA, other enzymes act as "glue" to join fragments together by catalyzing the formation of chemical bonds.

Solution:

1. Role of DNA Ligase:

DNA ligase is the enzyme responsible for joining DNA strands together by catalyzing the formation of a phosphodiester bond between the 3′-hydroxyl group of one nucleotide and the 5′-phosphate group of another.

2. Applications:

It is essential in DNA replication to join Okazaki fragments on the lagging strand. In recombinant DNA technology, it is used to seal a foreign DNA fragment into a plasmid vector.

3. Other Enzymes:

DNA Polymerase synthesizes new DNA. Helicase unwinds the double helix. Endonucleases cut DNA at specific internal sites.

Final Answer: DNA Ligase is the enzyme used to join DNA fragments.

Answer: (B)

Q14.

Solution

Concept:

The Miller-Urey experiment (1953) provided the first evidence that organic molecules needed for life could be formed from inorganic components under conditions simulating the primitive Earth.

Solution:

1. Simulation Parameters:

Stanley Miller created a closed system containing a mixture of gases that were believed to represent the Earth's early reducing atmosphere, excluding free oxygen (O_2).

2. The Gas Mixture:

The specific gases used were Methane (CH_4), Ammonia (NH_3), Hydrogen (H_2), and Water vapor (H_2O).

3. Energy Source:

Electric discharges (simulating lightning) were passed through the mixture at a temperature of 800°C.

4. Results:

After a week, Miller observed the formation of several amino acids, proving that the chemical evolution of life was plausible.

Final Answer: The gases used were CH_4, NH_3, H_2, H_2O.

Answer: (A)

Q15.

Solution

Concept:

Pulmonary volumes and capacities are used to measure the functionality of the respiratory system. Vital Capacity (VC) is the maximum volume of air a person can breathe out after a forced inspiration, or the maximum volume of air a person can breathe in after a forced expiration.

Solution:

1. Component Definitions:

Tidal Volume (TV): Normal volume of air inhaled/exhaled.

Inspiratory Reserve Volume (IRV): Extra air inhaled after a normal breath.

Expiratory Reserve Volume (ERV): Extra air exhaled after a normal breath.

2. Calculating Vital Capacity:

VC represents the sum of the three major exchangeable volumes:

$$VC = TV + IRV + ERV$$

3. Distinction from Total Lung Capacity (TLC):

TLC includes the Residual Volume (RV), which is the air that never leaves the lungs. VC does not include RV.

Final Answer: Vital Capacity is equal to $TV + IRV + ERV$.

Answer: (C)

Q16.

Solution

Concept:

The body's "emergency" or "fight-or-flight" response is governed by the sympathetic nervous system and the adrenal medulla.

When a person faces sudden stress, danger, or excitement, specific hormones are rapidly secreted into the bloodstream to prepare the body for immediate physical action.

Solution:

1. Identification of the Hormones:

The hormones are Catecholamines, specifically Adrenaline (Epinephrine) and Noradrenaline (Norepinephrine).

2. Source:

These are secreted by the adrenal medulla in response to signals from the sympathetic nervous system.

3. Physiological Effects:

- Increased heart rate and strength of heart contraction.
- Dilation of pupils (alertness).
- Breakdown of glycogen into glucose for immediate energy.
- Increased rate of respiration.

4. Comparison:

Insulin lowers blood sugar. Thyroxine regulates basal metabolic rate. Estrogen is a sex hormone for female reproductive development.

Final Answer: Epinephrine is known as the emergency hormone.

Answer: (C)

Q17.

Solution

Concept:

The human excretory system is composed of millions of microscopic structural and functional units called nephrons.

These units are responsible for the filtration of blood, reabsorption of essential nutrients, and the secretion of waste products to form urine.

Solution:

1. Structure of the Nephron:

Each nephron consists of two main parts: the Glomerulus (a tuft of capillaries) and the Renal Tubule (including Bowman's capsule, PCT, Henle's loop, and DCT).

2. Function:

The nephron processes the blood plasma to remove metabolic wastes like urea while maintaining the body's water and electrolyte balance.

3. Distinction:

A neuron is the functional unit of the nervous system.

Henle's loop and the Glomerulus are merely specific components within a single nephron.

Final Answer: The basic functional unit of the kidney is the Nephron.

Answer: (A)

Q18.

Solution

Concept:

The immune system consists of various organs where lymphocytes (white blood cells) are produced, matured, or interact with antigens.

These are categorized into Primary and Secondary lymphoid organs.

Solution:

1. Primary Lymphoid Organs:

These are the sites where immature lymphocytes differentiate into antigen-sensitive lymphocytes and undergo maturation.

The two primary lymphoid organs in humans are the Bone Marrow and the Thymus.

2. Secondary Lymphoid Organs:

These are sites where lymphocytes migrate after maturation to encounter antigens and proliferate.

Examples include the Spleen, Tonsils, Peyer's patches, and Lymph nodes.

3. Conclusion:

Among the options provided, Bone Marrow is the only primary lymphoid organ where B-cells mature and all blood cells are produced.

Final Answer: Bone Marrow is a primary lymphoid organ.

Answer: (C)

Q19.

Solution

Concept:

Digestion is a chemical process involving enzymes that break down complex food into absorbable forms.

Many proteolytic enzymes are secreted in an inactive "proenzyme" form to prevent them from digesting the organs that produce them.

Solution:

1. Origin of Enterokinase:

Enterokinase (also called enteropeptidase) is an enzyme secreted by the intestinal mucosa (brush border of the duodenum).

2. Action:

It acts on the inactive proenzyme Trypsinogen, which is secreted by the pancreas.

3. Activation Cascade:

Enterokinase cleaves a specific peptide bond in Trypsinogen to convert it into the active enzyme Trypsin.

Once activated, Trypsin then activates other pancreatic enzymes like Chymotrypsinogen and Procarboxypeptidase.

Final Answer: Enterokinase converts Trypsinogen to Trypsin.

Answer: (C)

Q20.

Solution

Concept:

In eukaryotes, the primary transcript (hnRNA) produced by transcription contains both coding and non-coding sequences.

Before this RNA can be translated into a protein, it must undergo "RNA processing" or "Splicing" in the nucleus.

Solution:

1. Exons vs. Introns:

Exons are the coding sequences that appear in mature, processed mRNA.

Introns are the non-coding intervening sequences that do not appear in the mature mRNA.

2. The Splicing Process:

Splicing is the process where introns are physically removed from the transcript, and exons are joined together in a specific order.

3. Significance:

This ensures that the genetic code is continuous and correct for protein synthesis.

Promoters and terminators are DNA sequences that regulate the start and end of transcription, but they are not involved in the splicing of the RNA transcript itself.

Final Answer: Splicing involves the removal of Introns.

Answer: (B)

Q21.

Solution

Concept:

The Hardy-Weinberg principle provides a mathematical baseline for a non-evolving population.

The equation for genotype frequencies is $p^2 + 2pq + q^2 = 1$, where:

p is the frequency of the dominant allele (A).

q is the frequency of the recessive allele (a).

p^2 is the frequency of the homozygous dominant genotype (AA).

Solution:

1. Given Information:

The frequency of the recessive allele (q) is 0.4.

2. Finding the Dominant Allele Frequency (p):

Since $p + q = 1$:

$p = 1 - 0.4 = 0.6$.

3. Calculating the Genotype Frequency (p^2):

The frequency of homozygous dominant individuals (AA) is p^2.

$p^2 = (0.6) \times (0.6) = 0.36$.

4. Additional Check:

Frequency of $Aa = 2pq = 2 \times 0.6 \times 0.4 = 0.48$.

Frequency of $aa = q^2 = 0.4 \times 0.4 = 0.16$.

Total: $0.36 + 0.48 + 0.16 = 1.0$.

Final Answer: The frequency of the homozygous dominant genotype (AA) is 0.36.

Answer: (B)

Q22.

Solution

Concept:

Adaptive radiation is an evolutionary process where a single ancestral species evolves into a variety of forms that occupy different ecological niches.

This usually occurs when a species enters a new environment with diverse resources and little competition.

Solution:

1. Darwin's Finches:

On the Galapagos Islands, a single ancestral finch species radiated into numerous species with different beak shapes adapted for eating seeds, insects, or cactus fruits.

2. Australian Marsupials:

A number of marsupials, each different from the other, evolved from an ancestral stock within the Australian island continent, resulting in forms like the kangaroo, sugar glider, and Tasmanian wolf.

3. Convergent vs. Adaptive:

When more than one adaptive radiation occurs in an isolated geographical area (representing different lineages), it can also lead to convergent evolution. However, both finches and marsupials are primary textbook examples of radiation from a single point.

Final Answer: Both Darwin's Finches and Australian Marsupials are examples of Adaptive Radiation.

Answer: (C)

Q23.

Solution

Concept:

Relaxin is a protein hormone that plays a crucial role in the female reproductive system, particularly during pregnancy and childbirth.

It is produced by several different tissues depending on the stage of the reproductive cycle and the species.

Solution:

1. Production in the Ovaries:

In humans, Relaxin is primarily secreted by the corpus luteum of the ovary.

2. Function during Pregnancy:

It helps to relax the pelvic ligaments and softens the cervix to facilitate the passage of the fetus through the birth canal during parturition.

3. Other Sources:

During pregnancy, the placenta also produces some relaxin. However, the corpus luteum remains the classic primary endocrine source mentioned in standard biological contexts.

4. Comparison:

The pituitary secretes LH and FSH. The adrenal gland secretes cortisol and adrenaline. The thyroid secretes thyroxine.

Final Answer: The hormone Relaxin is secreted by the Corpus luteum.

Answer: (A)

Q24.

Solution

Concept:

DNA fingerprinting (DNA profiling) involves identifying the unique patterns in an individual's DNA.

Since DNA molecules are negatively charged due to their phosphate groups, they can be moved through a medium using an electric field.

Solution:

1. Role of Gel Electrophoresis:

After DNA is cut into fragments by restriction enzymes, the mixture is loaded into a gel (usually agarose).

2. Separation Mechanism:

When an electric current is applied, DNA fragments move toward the positive anode. The gel acts as a sieve; smaller fragments move faster and further, while larger fragments move slower and stay closer to the origin.

3. Visualization:

This process separates the DNA fragments based on their size (length), creating the characteristic "bands" used for comparison.

4. Distinction:

PCR is used for amplification. Southern Blotting is the transfer of DNA to a membrane. Centrifugation separates based on density.

Final Answer: Gel Electrophoresis is used for the separation of DNA fragments.

Answer: (B)

Q25.

Solution

Concept:

The genetic code is the set of rules by which information encoded within genetic material (DNA or mRNA sequences) is translated into proteins by living cells.

It has several specific properties that ensure high fidelity in protein synthesis.

Solution:

1. Universal:

Nearly all organisms use the same code (e.g., *UUU* codes for Phenylalanine in bacteria and humans).

2. Degenerate:

Multiple codons can code for the same amino acid (e.g., six different codons code for Leucine).

3. Non-ambiguous:

One specific codon always codes for only one specific amino acid. For example, *AUG* always codes for Methionine. It is NOT ambiguous.

4. Non-overlapping:

The code is read in groups of three (codons) without sharing bases between adjacent codons.

Final Answer: The genetic code is non-ambiguous, so "Ambiguous" is NOT a feature of the code.

Answer: (C)

Q26.

Solution

Concept:

Microbes play a significant role in the industrial production of bioactive molecules and chemicals. Statins are a class of drugs used to lower blood cholesterol levels by competitively inhibiting the enzyme responsible for cholesterol synthesis in the liver.

Solution:

1. Identification of the Source:

Statins are produced by the yeast *Monascus purpureus*.

2. Mechanism of Action:

They act by competitively inhibiting the enzyme β-hydroxy-β-methylglutaryl-CoA (HMG-CoA) reductase.

By blocking this enzyme, the rate of cholesterol production in the body decreases.

3. Comparison with other microbes:

Trichoderma polysporum produces Cyclosporin A (an immunosuppressant).

Saccharomyces cerevisiae is primarily used in the brewing and baking industries.

Aspergillus niger is used for the production of citric acid.

Final Answer: Statins are extracted from the yeast *Monascus purpureus*.

Answer: (A)

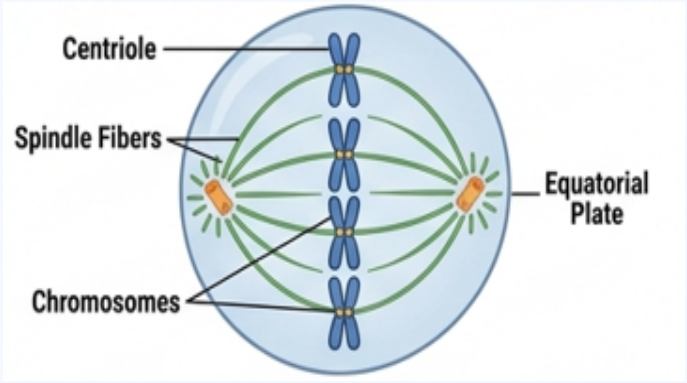
Q27.

Solution

Concept:

Mitosis is divided into several stages: Prophase, Metaphase, Anaphase, and Telophase.

Each stage is characterized by the specific behavior and position of the chromosomes within the cell.



Solution:

1. Characteristics of Metaphase:

This stage follows the disappearance of the nuclear envelope.

Spindle fibers from opposite poles attach to the kinetochores of the sister chromatids.

2. Chromosome Alignment:

The chromosomes are moved to the center of the cell and get aligned along the metaphase plate (equatorial plate) through the spindle fibers.

3. Significance:

This alignment ensures that each daughter cell will receive an equal and identical set of chromosomes during the subsequent stage (Anaphase).

4. Other stages:

In Prophase, chromosomes condense. In Anaphase, sister chromatids separate. In Telophase, new nuclei form.

Final Answer: Metaphase is the stage where chromosomes align at the equatorial plate.

Answer: (B)

Q28.

Solution

Concept:

Vestigial organs are structures or organs that were functional in ancestral species but have lost most or all of their original function in the descendant species due to evolution.

In humans, several such remnants exist.

Solution:

1. Nictitating Membrane:

In many animals, this is a functional third eyelid. In humans, it is reduced to the plica semilunaris in the corner of the eye.

2. Ear Muscles (Auricular Muscles):

While some animals use these to move their ears to localize sound, they are non-functional for most humans.

3. Vermiform Appendix:

This structure was likely involved in the digestion of cellulose in our herbivorous ancestors. In modern humans, it no longer serves a digestive function.

4. Conclusion:

All three examples provided are recognized as vestigial structures in the human body.

Final Answer: All of the above are vestigial organs in humans.

Answer: (D)

Q29.

Solution

Concept:

Capacitation is the penultimate step in the maturation of mammalian spermatozoa.

While sperm are produced in the testes and mature in the epididymis, they are not immediately capable of fertilizing an egg.

Solution:

1. Definition of Capacitation:

It is a physiological change that sperm undergo to acquire the ability to penetrate and fertilize an oocyte.

2. Location:

This process occurs only after the sperm have been deposited into the female reproductive tract (uterus and fallopian tubes).

3. Changes involved:

The process involves the removal of inhibitory proteins and cholesterol from the sperm cell membrane, increasing its permeability to calcium and enhancing sperm motility (hyperactivation).

4. Significance:

Without capacitation, the acrosome reaction cannot occur, rendering the sperm unable to penetrate the egg's protective layers.

Final Answer: Capacitation occurs in the female reproductive tract.

Answer: (C)

Q30.

Solution

Concept:

Carbohydrates are classified as reducing or non-reducing based on their ability to act as reducing agents.

A sugar is "reducing" if it has a free aldehyde or ketone group (or a hemiacetal/hemiketal group) that can reduce alkaline solutions of copper (like Fehling's or Benedict's solution).

Solution:

1. Reducing Sugars:

All monosaccharides, such as Glucose and Fructose, are reducing sugars.

Disaccharides like Lactose and Maltose are also reducing because they retain a free reactive group.

2. The Case of Sucrose:

Sucrose is a disaccharide composed of glucose and fructose.

In sucrose, the glycosidic bond is formed between the reducing groups of both monosaccharides (the C_1 of glucose and C_2 of fructose).

3. Conclusion:

Because both reactive groups are tied up in the bond, sucrose lacks a free aldehyde or ketone group. Therefore, it is a non-reducing sugar.

Final Answer: Sucrose is a non-reducing sugar.

Answer: (C)

Q31.

Solution

Concept:

Plants are categorized as C_3 or C_4 based on the first stable product formed during the dark reaction of photosynthesis (CO_2 fixation).

C_4 plants have evolved a specialized mechanism to minimize photorespiration by using a two-step carbon fixation process occurring in different cell types (Mesophyll and Bundle Sheath cells).

Solution:

1. Initial Fixation:

In C_4 plants, the primary CO_2 acceptor is Phosphoenolpyruvate (PEP), a 3-carbon molecule present in the mesophyll cells.

2. Enzyme Involved:

The reaction is catalyzed by the enzyme PEP carboxylase (PEPcase). Unlike RuBisCO, PEPcase has no affinity for oxygen, preventing photorespiration.

3. Formation of the Product:

The fixation of CO_2 to PEP results in the formation of Oxaloacetic Acid (OAA), which is a 4-carbon organic acid.

4. Conclusion:

Because this first stable product contains 4 carbons, these plants are named C_4 plants. OAA is subsequently converted into other 4-carbon compounds like malic acid before being transported to bundle sheath cells.

Final Answer: In C_4 plants, the first stable product of CO_2 fixation is Oxaloacetic Acid (OAA).

Answer: (B)

Q32.

Solution

Concept:

The Chemiosmotic Hypothesis, proposed by Peter Mitchell, explains the mechanism of ATP synthesis in both chloroplasts (during photosynthesis) and mitochondria (during respiration).

It links the movement of electrons through an electron transport chain to the production of chemical energy.

Solution:

1. Creation of the Gradient:

As electrons move through the transport system, energy is used to pump protons (H^+) across a membrane (thylakoid membrane in plants or inner mitochondrial membrane in animals).

2. Accumulation:

This results in a high concentration of protons on one side of the membrane, creating a proton gradient or proton motive force.

3. ATP Synthesis:

The potential energy stored in this gradient is released when protons flow back through a specialized enzyme complex called ATP synthase ($F_0 - F_1$ particle).

4. Conclusion:

Without the establishment of a significant proton gradient, the ATP synthase enzyme cannot function to phosphorylate ADP into ATP.

Final Answer: The chemiosmotic mechanism strictly requires a Proton gradient.

Answer: (A)

Q33.

Solution

Concept:

Plant growth regulators (hormones) control various physiological processes.

'Bolting' refers to the sudden and rapid elongation of internodes in plants with a rosette habit (like cabbage or beet) just prior to flowering.

Solution:

1. Role of Gibberellins:

Gibberellins (GA) are primary regulators of stem elongation. They promote cell division and cell enlargement in the sub-apical meristem.

2. Induction of Bolting:

In rosette plants, internode growth is naturally retarded. The application of exogenous gibberellins mimics environmental cues (like long days or cold treatment), causing the stem to "bolt" or shoot up.

3. Comparison:

Auxins promote apical dominance. Cytokinins promote cell division and delay senescence. Ethylene is a gaseous hormone primarily involved in fruit ripening.

Final Answer: Gibberellin is the hormone responsible for Bolting.

Answer: (B)

Q34.

Solution

Concept:

Assisted Reproductive Technologies (ART) are used to treat infertility.

GIFT (Gamete Intra Fallopian Transfer) is a technique where both sperm and unfertilized eggs are transferred directly into the woman's fallopian tubes.

Solution:

1. Condition for GIFT:

This method is specifically designed for women who cannot produce their own ova (eggs) but possess a functional uterus and healthy fallopian tubes.

2. Mechanism:

An egg from a donor (or the patient, if possible) and sperm from the partner are collected and placed into the fallopian tube, where fertilization occurs naturally inside the body (in vivo).

3. Distinction from IVF:

In IVF (In Vitro Fertilization), fertilization happens in a lab, and the resulting embryo is transferred. In GIFT, the woman's body provides the site for fertilization.

4. Selection:

If a woman has blocked tubes, GIFT cannot be used; techniques like ZIFT or IVF would be required.

Final Answer: GIFT is recommended for females who cannot produce an ovum but can provide a suitable environment for fertilization.

Answer: (A)

Q35.

Solution

Concept:

Restriction endonucleases, often called "molecular scissors," are enzymes used in biotechnology to cut DNA at very specific locations.

Each restriction enzyme recognizes a specific sequence of nucleotides, usually 4 to 8 base pairs long.

Solution:

1. Nature of the Recognition Site:

The specific DNA sequence recognized by these enzymes is called a Palindromic sequence.

2. Definition of Palindrome in DNA:

A DNA palindrome is a sequence where the base sequence on one strand read in the $5' \rightarrow 3'$ direction is identical to the sequence on the complementary strand read in the $5' \rightarrow 3'$ direction.

3. Example:

The enzyme EcoRI recognizes the sequence:

5′–GAATTC–3′

3′–CTTAAG–5′

4. Conclusion:

The enzyme scans the DNA and only makes a cut when it encounters its unique palindromic recognition site.

Final Answer: A restriction enzyme cuts DNA at a Palindromic sequence.

Answer: (A)

Q36.

Solution

Concept:

Bt cotton is a genetically modified crop containing a toxin gene from the soil bacterium *Bacillus thuringiensis*.

The toxin (Bt toxin) exists in an inactive crystalline form (protoxin) within the plant and only becomes harmful under specific conditions.

Solution:

1. Ingestion:

When an insect (like a bollworm) feeds on the Bt cotton plant, it ingests the inactive protoxin crystals.

2. Activation:

Inside the insect's gut, the alkaline pH of the midgut solubilizes the protein crystals, converting the protoxin into an active toxin.

3. Mechanism of Death:

The activated toxin binds to the surface of the midgut epithelial cells.

It creates pores in the cell membrane, causing cell swelling and lysis.

4. Conclusion:

These pores lead to the destruction of the digestive tract, causing the insect to stop feeding and eventually die of starvation and tissue damage.

Final Answer: The Bt toxin kills insects by creating pores in the midgut epithelial cells.

Answer: (B)

Q37.

Solution

Concept:

Double fertilization is a unique and complex fertilization mechanism found exclusively in flowering plants (Angiosperms).

It involves two separate fusion events occurring simultaneously within the embryo sac.

Solution:

1. Syngamy:

One male gamete fuses with the egg cell (female gamete) to form a diploid zygote ($2n$). This zygote eventually develops into the embryo.

2. Triple Fusion:

The second male gamete moves toward the center of the embryo sac and fuses with the two polar nuclei (or the secondary nucleus) to form a triploid Primary Endosperm Nucleus (PEN, $3n$).

3. Significance:

The endosperm provides essential nourishment to the developing embryo.

4. Conclusion:

While Gymnosperms have a different mechanism (endosperm is formed before fertilization and is haploid), double fertilization is the defining hallmark of Angiosperms.

Final Answer: Double fertilization is a characteristic feature of Angiosperms.

Answer: (B)

Q38.

Solution

Concept:

In plant biotechnology, specific vectors are needed to deliver foreign DNA into plant cells.

The most widely used vector is derived from a soil-borne bacterium that naturally possesses the ability to transform plant cells.

Solution:

1. The Natural Engineer:

Agrobacterium tumefaciens is a pathogen that causes Crown Gall disease in plants by transferring a piece of its DNA into the host genome.

2. The Ti Plasmid:

The bacterium contains a large plasmid called the Ti (Tumor-inducing) plasmid.

3. Modification for Biotechnology:

Scientists have "disarmed" this plasmid by removing the disease-causing genes while retaining the T-DNA (transfer DNA) region.

This allows the Ti plasmid to be used as a reliable vehicle to deliver desired genes into a wide variety of plants.

Final Answer: The Ti plasmid is obtained from *Agrobacterium tumefaciens*.

Answer: (A)

Q39.

Solution

Concept:

Biodiversity conservation strategies are divided into two main categories: In-situ (on-site) and Ex-situ (off-site).

Ex-situ conservation involves removing organisms from their threatened natural habitats and placing them under human care in a controlled environment.

Solution:

1. Ex-situ Methods:

These include Botanical Gardens, Zoological Parks, and specialized storage facilities like Seed Banks or Gene Banks.

2. Seed Banks:

In a Seed Bank, seeds are stored at extremely low temperatures and controlled humidity. This preserves the genetic diversity of plants for long periods outside their natural ecosystem.

3. In-situ Methods:

National Parks, Wildlife Sanctuaries, and Biosphere Reserves are examples of In-situ conservation, as they protect the entire ecosystem in its original location.

Final Answer: A Seed Bank is a method of Ex-situ conservation.

Answer: (C)

Q40.

Solution

Concept:

Water potential (Ψ_w) is a measure of the free energy of water in a system, which determines the direction of water movement.

By convention, the water potential of pure water is used as the standard reference point.

Solution:

1. Standard Conditions:

At standard temperature (25°C) and in the absence of any external pressure, the water potential of pure water is defined as zero.

2. Effect of Solutes:

When a solute is added to pure water, the concentration of free water molecules decreases, reducing the free energy.

Therefore, the water potential of any solution is always a negative value (less than zero).

3. Movement Principle:

Water always moves from a region of higher water potential (closer to zero) to a region of lower water potential (more negative).

Final Answer: The water potential of pure water at standard temperature is 0.

Answer: (A)

Q41.

Solution

Concept:

Biological nitrogen fixation is the process of converting atmospheric nitrogen (N_2) into ammonia (NH_3).

This process is carried out by specialized prokaryotes, such as *Rhizobium* in the root nodules of leguminous plants.

The reaction is highly energy-intensive and requires a specific enzyme complex.

Solution:

1. Identification of the Enzyme:

The key enzyme responsible for reducing nitrogen to ammonia is Nitrogenase.

2. Structural Components:

Nitrogenase is a Mo-Fe (Molybdenum-Iron) protein. It is extremely sensitive to molecular oxygen and functions only under anaerobic conditions.

3. Protection Mechanism:

To protect this enzyme from oxygen, root nodules contain an oxygen scavenger called leg-hemoglobin, which gives the nodules a pinkish color.

4. Energy Requirement:

The process requires a significant amount of energy in the form of ATP (16 ATP for every molecule of N_2 fixed), which is provided by the host plant's respiration.

Final Answer: The enzyme Nitrogenase catalyzes nitrogen fixation in root nodules.

Answer: (A)

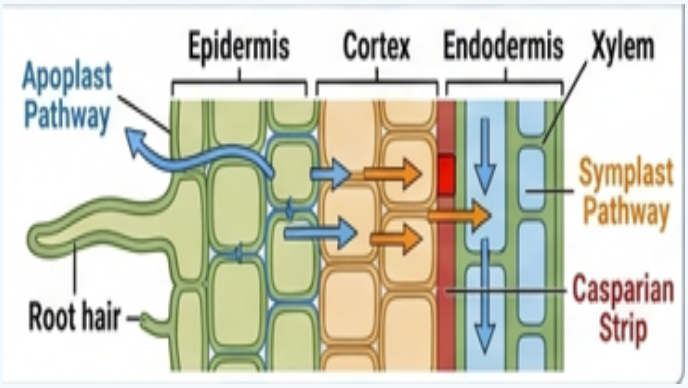
Q42.

Solution

Concept:

Water movement in plants occurs through different pathways in the root layers (epidermis, cortex, endodermis).

These pathways are categorized based on whether the water moves through the living parts of the cell or the non-living spaces.



Solution:

1. Apoplast Pathway:

This is the pathway where water and minerals move exclusively through the cell walls and the intercellular spaces between cells.

2. Characteristics:

Movement in the apoplast is fast because it does not involve crossing the cell membrane or moving through the viscous cytoplasm. It is driven by gradient and mass flow.

3. Symplast Pathway:

In contrast, the symplast pathway involves water moving through the cytoplasm of cells, connected by plasmodesmata. This movement is slower as it crosses the selectively permeable plasma membrane.

4. The Casparian Strip:

At the endodermis, the apoplastic movement is blocked by suberin (Casparian strip), forcing water into the symplastic pathway to enter the vascular cylinder.

Final Answer: The movement through cell walls and intercellular spaces is called the Apoplast pathway.

Answer: (B)

Q43.

Solution

Concept:

The genetic code consists of 64 codons. Out of these, 61 codons code for amino acids, while 3 codons do not code for any amino acid.

These three are known as stop codons or termination codons because they signal the end of protein synthesis during translation.

Solution:

1. The Stop Codons:

The three stop codons are:

- UAA (Ochre)
- UAG (Amber)
- UGA (Opal)

2. Function:

When a ribosome encounters one of these codons on the mRNA, no tRNA molecule binds to it. Instead, release factors bind, causing the newly synthesized polypeptide chain to be released.

3. Comparison:

AUG is the start codon (coding for Methionine).

UGG codes for Tryptophan.

GUG usually codes for Valine (but can act as an alternative start codon in some cases).

Final Answer: UAA is a stop codon.

Answer: (B)

Q44.

Solution

Concept:

Transgenic animals are created by inserting foreign genes into their genome to produce useful biological products.

One of the earliest successful examples was a transgenic cow created to produce milk that was more nutritionally balanced for human infants than natural cow milk.

Solution:

1. The Transgenic Cow 'Rosie':

Rosie was produced in 1997. She carried a human gene that allowed her to secrete a specific human protein into her milk.

2. Nutritional Improvement:

The milk contained human α-lactalbumin (2.4 grams per liter).

3. Significance:

Natural cow milk lacks certain proteins found in human milk. Rosie's milk provided a nutritionally superior alternative for human babies who could not be breastfed, as α-lactalbumin is a key component of human breast milk.

Final Answer: Rosie's milk was enriched with Human α-lactalbumin.

Answer: (A)

Q45.

Solution

Concept:

The development of insect-resistant crops is a major achievement in agricultural biotechnology. The most common strategy involves using specific genes from a soil bacterium that produce proteins toxic to certain insect larvae.

Solution:

1. Source Organism:

The 'Cry' genes (standing for crystal) are isolated from the bacterium *Bacillus thuringiensis*.

2. Protein Production:

These genes code for Bt toxin proteins. When expressed in plants, these proteins accumulate as crystals.

3. Target Specificity:

There are several types of Cry genes, each effective against different pests. For example, $cryIAc$ and $cryIIAb$ control cotton bollworms, while $cryIAb$ controls corn borer.

4. Conclusion:

By transferring these genes into crops, the plants become naturally resistant to specific insect pests without the need for excessive chemical pesticides.

Final Answer: 'Cry' genes are obtained from *Bacillus thuringiensis*.

Answer: (A)

Q46.

Solution

Concept:

After fertilization in flowering plants, the flower undergoes several structural transformations. The floral parts that have served their purpose (like petals and stamens) usually wither and fall off, while the reproductive organs develop into the fruit and seed.

Solution:

1. Ovary Transformation:

The ovary is the basal, swollen part of the pistil. Following fertilization, the ovary wall ripens and thickens to become the fruit wall (pericarp), and the entire ovary matures into the fruit.

2. Ovule Transformation:

The ovules, which are contained within the ovary, undergo development to become the seeds of the plant.

3. Other Parts:

The integuments of the ovule become the seed coats (testa and tegmen).

The zygote within the ovule develops into the embryo.

4. Conclusion:

Therefore, the botanical definition of a fruit is a "matured or ripened ovary."

Final Answer: The ovary is the part of the flower that develops into a fruit.

Answer: (B)

Q47.

Solution

Concept:

Pollination is the transfer of pollen grains from the anther to the stigma.

Plants use various biotic (animals, insects) and abiotic (wind, water) agents to achieve this.

Specific terminology is used to describe pollination based on the agent involved.

Solution:

1. Anemophily:

This is pollination by wind. Wind-pollinated plants often have small, inconspicuous flowers, lack nectar and scent, and produce large quantities of light, non-sticky pollen.

2. Hydrophily:

This refers to pollination by water, which is relatively rare and limited to about 30 genera, mostly monocotyledons (e.g., Vallisneria).

3. Entomophily:

This is pollination by insects, characterized by large, colorful, and fragrant flowers that produce nectar.

4. Ornithophily:

This refers to pollination by birds.

Final Answer: Pollination by wind is called Anemophily.

Answer: (A)

Q48.

Solution

Concept:

In the life cycle of flowering plants, the formation of spores is a critical step.

Megasporogenesis is the process specifically related to the formation of female gametophyte precursors.

Solution:

1. Starting Point:

The process begins with a diploid ($2n$) cell called the Megaspore Mother Cell (MMC), located in the nucellus of the ovule.

2. Meiotic Division:

The MMC undergoes meiosis to produce four haploid (n) megaspores.

3. Functional Megaspore:

In most flowering plants, three of the four megaspores degenerate, and only one remains functional. This functional megaspore then develops into the embryo sac.

4. Microsporogenesis:

In contrast, microsporogenesis is the formation of microspores (which become pollen grains) from a pollen mother cell in the anther.

Final Answer: The formation of a megaspore from a megaspore mother cell is Megasporogenesis.

Answer: (A)

Q49.

Solution

Concept:

Metabolites are the intermediate or end products of metabolism.

They are classified into primary and secondary metabolites based on their role in the growth and survival of the organism.

Solution:

1. Primary Metabolites:

These are directly involved in normal growth, development, and reproduction. Examples include carbohydrates (glucose), proteins (amino acids), and lipids (fats). They are found in all cells and have identifiable physiological roles.

2. Secondary Metabolites:

These are not directly involved in basic survival processes but play roles in ecological interactions, such as defense against herbivores or attraction of pollinators.

3. Alkaloids:

Alkaloids (like morphine, quinine, or nicotine) are classic examples of secondary metabolites. They are often produced by specific groups of plants or fungi and are widely used in medicine.

Final Answer: Alkaloids are secondary metabolites.

Answer: (C)

Q50.

Solution

Concept:

Photorespiration (the C_2 cycle) is a wasteful process that occurs in C_3 plants when the enzyme RuBisCO binds with oxygen instead of carbon dioxide.

This happens under conditions of high temperature and high light intensity when oxygen levels inside the leaf increase.

Solution:

1. Initial Reaction:

RuBisCO acts as an oxygenase and catalyzes the oxygenation of Ribulose-1,5-bisphosphate (RuBP).

2. Products of Oxygenation:

This results in one molecule of 3-phosphoglycerate (3-PGA) and one molecule of a 2-carbon compound called Phosphoglycolate.

3. The Substrate:

Phosphoglycolate is rapidly dephosphorylated to form Glycolate.

Glycolate then moves from the chloroplast to the peroxisome, acting as the primary substrate for the photorespiratory pathway.

4. Conclusion:

Therefore, Glycolate is the key substrate that enters the metabolic pathway of photorespiration.

Final Answer: The substrate for photorespiration is Glycolate.

Answer: (A)

Q51.

Solution

Concept:

The Polymerase Chain Reaction (PCR) is a technique used to amplify a specific segment of DNA into millions of copies.

It is a cycle-based process involving specific temperature changes, catalyzed by a heat-stable DNA polymerase (such as Taq polymerase).

Solution:

1. Steps in PCR:

- **Denaturation:** Heating the DNA to approximately 94°C to separate the double strands.
- **Annealing:** Cooling the mixture to about 50 – 65°C to allow primers to bind to the complementary sequences on the single-stranded DNA.
- **Extension:** Heating to 72°C where the polymerase adds nucleotides to the primers to synthesize new DNA strands.

2. Evaluation of Splicing:

Splicing is a biological process occurring inside eukaryotic nuclei where introns are removed from primary RNA transcripts. It is not a component of the in-vitro PCR process.

3. Conclusion:

While denaturation, annealing, and extension are the three fundamental stages of a PCR cycle, splicing is entirely unrelated to DNA amplification techniques.

Final Answer: Splicing is NOT a step in PCR.

Answer: (D)

Q52.

Solution

Concept:

International environmental agreements are designed to address specific global threats.

The Montreal Protocol is one of the most successful environmental treaties, signed in 1987 (and effective in 1989).

Solution:

1. Purpose:

The primary goal of the Montreal Protocol is to protect the stratospheric ozone layer.

2. Mechanism:

It mandates the phase-out of the production and consumption of ozone-depleting substances (ODS), primarily Chlorofluorocarbons (CFCs) and Halons.

3. Distinction from Kyoto:

While the Kyoto Protocol focuses on reducing greenhouse gas emissions to combat global warming, the Montreal Protocol specifically targets chemicals that destroy the ozone shield.

4. Impact:

Since its implementation, the atmospheric concentrations of the most important chlorofluorocarbons and related chlorinated hydrocarbons have either leveled off or decreased.

Final Answer: The Montreal Protocol is related to Ozone depletion.

Answer: (B)

Q53.

Solution

Concept:

Humulin is the brand name for the first biosynthetic "human" insulin developed using recombinant DNA technology.

Prior to its development, diabetic patients were treated with insulin extracted from the pancreases of slaughtered cows and pigs, which often caused allergic reactions.

Solution:

1. Production:

In 1983, an American company called Eli Lilly prepared two DNA sequences corresponding to the A and B chains of human insulin.

2. Methodology:

These sequences were introduced into plasmids of *E. coli* to produce insulin chains separately. The chains were then extracted and combined by creating disulfide bonds.

3. Nature of the Product:

Because the sequence used was identical to the human gene, the resulting protein (Humulin) was chemically identical to human-produced insulin and did not cause the immune responses associated with animal-derived insulin.

Final Answer: Humulin is Human Insulin.

Answer: (A)

Q54.

Solution

Concept:

PCR (Polymerase Chain Reaction) revolutionized molecular biology by allowing scientists to make billions of copies of a tiny DNA sample in a very short time.

Solution:

1. The Inventor:

The technique was developed by American biochemist Kary Mullis in 1983.

2. Significance of the Work:

His discovery of using a thermal cycling process and a heat-stable enzyme allowed for the automation of DNA amplification.

3. Recognition:

For this invention, Kary Mullis was awarded the Nobel Prize in Chemistry in 1993.

4. Comparison:

Watson and Crick discovered the double helix structure. Mendel is the father of genetics. Morgan worked on linkage and fruit flies.

Final Answer: PCR was developed by Kary Mullis.

Answer: (A)

Q55.

Solution

Concept:

The immune system is divided into innate and acquired immunity.

Innate immunity is non-specific and provides the first line of defense from birth. It consists of physical, physiological, cellular, and cytokine barriers.

Solution:

1. Physical Barriers:

These act as the primary "wall" to prevent entry of microorganisms into the body. The main physical barrier is the skin (specifically the stratum corneum).

2. Mucous Membranes:

The mucus coating of the epithelium lining the respiratory, gastrointestinal, and urogenital tracts also acts as a physical trap for microbes.

3. Other Barriers:

Interferons are cytokine barriers. Monocytes and Neutrophils are cellular barriers. Fever and stomach acid are physiological barriers.

4. Conclusion:

Among the choices, the skin is the most prominent physical structure that blocks the entry of pathogens.

Final Answer: Skin is a physical barrier of the innate immune system.

Answer: (A)

Q56.

Solution

Concept:

Decomposition is the process by which complex organic matter (detritus) is broken down into simpler inorganic substances like carbon dioxide, water, and nutrients.

This process involves several steps: fragmentation, leaching, catabolism, humification, and mineralization.

Solution:

1. Definition of Leaching:

Leaching is a specific physical process during decomposition where water-soluble substances are moved.

2. Mechanism:

As water (from rain or irrigation) percolates through the detritus and the upper layers of soil, it dissolves water-soluble inorganic nutrients.

3. Outcome:

These dissolved nutrients get carried down into the deeper soil horizons and often become precipitated as unavailable salts.

4. Comparison:

Fragmentation is the breaking of detritus by detritivores (like earthworms). Catabolism is the enzymatic degradation by bacteria and fungi.

Final Answer: Leaching refers to water-soluble inorganic nutrients going down into the soil.

Answer: (B)

Q57.

Solution

Concept:

The greenhouse effect is a natural process that warms the Earth's surface.

When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases.

Solution:

1. Greenhouse Gases (GHGs):

These are gases that have the property of absorbing infrared radiation (net heat energy) emitted from Earth's surface and reradiating it back to Earth's surface.

2. Major GHGs:

The primary greenhouse gases are Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), and Chlorofluorocarbons (CFCs).

3. Non-Greenhouse Gases:

The major components of our atmosphere, Nitrogen (78%), Oxygen (21%), and Argon (0.9%), do not act as greenhouse gases because they do not absorb infrared radiation.

4. Conclusion:

Methane is a potent greenhouse gas, significantly more effective at trapping heat than CO_2 on a per-molecule basis.

Final Answer: Methane is a greenhouse gas.

Answer: (A)

Q58.

Solution

Concept:

A lichen is not a single organism; it is a stable, self-supporting symbiotic association.

This partnership is so close that the two components appear as one individual.

Solution:

1. The Components:

A lichen consists of an alga (the phycobiont) or a cyanobacterium and a fungus (the mycobiont).

2. Functional Roles:

- The Algal component is autotrophic; it performs photosynthesis to prepare food for both partners.
- The Fungal component provides shelter, absorbs mineral nutrients, and provides water for its partner.

3. Symbiotic Nature:

This is a mutualistic relationship where both organisms benefit significantly. Lichens are also well-known indicators of air pollution, as they do not grow in areas with high sulfur dioxide levels.

Final Answer: Lichen is a symbiotic association between Algae and Fungi.

Answer: (A)

Q59.

Solution

Concept:

Energy flow is a fundamental process in an ecosystem. It follows the laws of thermodynamics, specifically the 10% law of energy transfer between trophic levels.

Solution:

1. The Source:

The Sun is the primary source of energy for all ecosystems on Earth (except deep-sea hydrothermal vents).

2. Direction of Flow:

Energy is captured by producers (green plants) through photosynthesis. It is then passed to primary consumers (herbivores), then to secondary consumers (carnivores), and so on.

3. Thermodynamic Constraint:

At each step, a significant amount of energy is lost as heat to the environment during respiration and metabolic activities.

4. Conclusion:

Energy once lost as heat can never be recaptured by the previous trophic level or the Sun. Therefore, the flow is strictly unidirectional (one-way).

Final Answer: In an ecosystem, the flow of energy is Unidirectional.

Answer: (A)

Q60.

Solution

Concept:

Ecological succession is the process of change in the species structure of an ecological community over time.

Primary succession occurs in essentially lifeless areas—regions where there is no soil, such as on bare rocks.

Solution:

1. Pioneer Species:

The first organisms to colonize a bare area are called pioneer species.

2. Succession on Rocks (Xerarch):

Lichens are the typical pioneer species on bare rocks. They secrete organic acids that chemically weather the rock, breaking it down into small particles to form the beginnings of soil.

3. Subsequent Stages:

The thin layer of soil and organic matter provided by dead lichens allows mosses to take hold. Mosses further trap soil and moisture, eventually allowing grasses, shrubs, and finally trees to grow.

Final Answer: Lichens are the pioneer species in primary succession on rocks.

Answer: (B)

Q61.

Solution

Concept:

The classification of living organisms has evolved from a simple two-kingdom system to more complex structures as our understanding of genetics and cell biology has improved.

The most widely accepted modern classification system is the Five-Kingdom Classification.

Solution:

1. Identification of the Scientist:

The Five-Kingdom system was proposed by Robert H. Whittaker (R.H. Whittaker) in 1969.

2. Criteria for Classification:

Whittaker used five main criteria:

- Cell structure (Prokaryotic vs. Eukaryotic)
- Thallus organization (Body complexity)
- Mode of nutrition (Autotrophic vs. Heterotrophic)
- Reproduction
- Phylogenetic relationships (Evolutionary history)

3. The Five Kingdoms:

The kingdoms are Monera, Protista, Fungi, Plantae, and Animalia.

4. Comparison:

Linnaeus proposed the Two-Kingdom system. Aristotle was the first to classify organisms based on simple morphological characters.

Final Answer: The five-kingdom classification was proposed by Whittaker.

Answer: (B)

Q62.

Solution

Concept:

Cell organelles are specialized structures within a cell that perform specific functions.

One particular organelle is responsible for the conversion of nutrients into usable chemical energy through the process of cellular respiration.

Solution:

1. Identification:

The Mitochondria are known as the "Powerhouse of the Cell."

2. Mechanism:

They are the primary sites of aerobic respiration. They produce energy in the form of Adenosine Triphosphate (ATP) by oxidizing carbohydrates and fats.

3. Structure:

Mitochondria are double-membrane structures. The inner membrane is folded into "cristae" to increase the surface area for the chemical reactions of the Electron Transport Chain.

4. Comparison:

Ribosomes are for protein synthesis. The nucleus is the control center (genetic material). The vacuole is primarily for storage and maintaining turgor pressure.

Final Answer: Mitochondria is the "Powerhouse of the cell."

Answer: (B)

Q63.

Solution

Concept:

Plants that grow in specific environments develop unique morphological adaptations to survive. Mangroves (Halophytes) grow in swampy, saline areas where the soil is waterlogged and deficient in oxygen.

Solution:

1. The Problem:

Because the soil is saturated with water, the roots of mangrove plants cannot access enough oxygen for respiration (asphyxiation).

2. The Adaptation:

To overcome this, many mangroves develop specialized roots called Pneumatophores (respiratory roots).

3. Function:

These roots grow vertically upward, emerging out of the water/mud like spikes. They contain numerous small pores called lenticels through which the plant can exchange gases directly with the atmosphere.

4. Examples:

Rhizophora is a classic example of a plant possessing pneumatophores.

Final Answer: Pneumatophores are found in Mangrove plants.

Answer: (A)

Q64.

Solution

Concept:

A floral formula is a symbolic representation of the structure of a flower, describing the symmetry, sex, and arrangement of its parts (Calyx, Corolla, Androecium, and Gynoecium).

Solution:

1. Characteristics of Solanaceae (Potato Family):

- Symmetry: Actinomorphic (radial symmetry), represented by $\oplus$.
- Sex: Bisexual, represented by ♀♂.
- Calyx (K): 5 sepals, gamosepalous (fused), represented by $K_{(5)}$.
- Corolla (C): 5 petals, gamopetalous (fused), represented by $C_{(5)}$.
- Androecium (A): 5 stamens, epipetalous (attached to petals), represented by A_5 with a line over C and A.
- Gynoecium (G): Bicarpellary, syncarpous (fused), superior ovary, represented by $\underline{G}_{(2)}$.

2. Evaluation:

Option A correctly lists these parameters: $\oplus$♀♂$K_{(5)}C_{(5)}A_5G_{(2)}$.

Final Answer: The floral formula of Solanaceae is $\oplus$♀♂$K_{(5)}C_{(5)}A_5G_{(2)}$.

Answer: (A)

Q65.

Solution

Concept:

The earthworm (*Pheretima posthuma*) has a segmented body. Certain segments are specialized to form structures involved in reproduction and cocoon formation.

Solution:

1. Definition of Clitellum:

The clitellum is a prominent circular band of glandular tissue that secretes mucus and the material that forms the cocoon during mating.

2. Location in Earthworms:

In a mature earthworm, the clitellum is found in segments 14, 15, and 16.

3. Body Divisions:

Based on the position of the clitellum, the body of the earthworm is divided into three regions: pre-clitellar, clitellar, and post-clitellar.

4. Significance:

The presence of a clitellum is a definitive sign that the earthworm has reached sexual maturity.

Final Answer: In earthworms, the clitellum is present in segments 14-16.

Answer: (A)

Q66.

Solution

Concept:

Birds belong to the class Aves. While most birds are adapted for flight with specialized structures like feathers, wings, and hollow bones (pneumatic bones), some species have lost the ability to fly through evolution, usually due to a lack of predators in their natural habitats.

Solution:

1. Characteristics of Flightless Birds:

These birds have reduced wings and lack a "keel" on their sternum (breastbone), which is the site where flight muscles typically attach.

2. Identification:

The Ostrich (*Struthio camelus*) is the largest living bird and is a well-known flightless bird native to Africa.

3. Other Examples:

Other flightless birds include the Kiwi, Emu, Cassowary, and Rhea.

4. Comparison:

Pigeons, peacocks, and sparrows are all capable of flight, although peacocks generally fly short distances and stay close to the ground.

Final Answer: The Ostrich is a flightless bird.

Answer: (A)

Q67.

Solution

Concept:

Species interactions in an ecosystem can be beneficial, harmful, or neutral.

Mutualism is a type of symbiotic relationship where both species involved derive a benefit that improves their chances of survival or reproduction.

Solution:

1. Structure of Mycorrhiza:

Mycorrhiza is a symbiotic association between a fungus and the roots of higher plants.

2. Benefits to the Plant:

The fungal hyphae have a massive surface area, allowing them to absorb water and essential minerals (especially phosphorus) from the soil much more efficiently than the plant roots alone.

3. Benefits to the Fungus:

In return, the plant provides the fungus with energy-rich carbohydrates (glucose) produced during photosynthesis.

4. Conclusion:

Since both the fungus and the plant benefit from this interaction (+/+), it is a classic example of mutualism.

Final Answer: Mycorrhiza is an example of Mutualism.

Answer: (B)

Q68.

Solution

Concept:

A biodiversity "hotspot" is a biogeographic region that is both a significant reservoir of biodiversity and is threatened with destruction.

To qualify as a hotspot, a region must meet strict criteria regarding species endemism and habitat loss.

Solution:

1. Biodiversity Hotspots in India:

India is home to several globally recognized hotspots:

- The Western Ghats and Sri Lanka
- The Himalayas
- Indo-Burma
- Sundaland (includes Nicobar Islands)

2. Characteristics of Western Ghats:

The Western Ghats represent a mountain range along the western coast of India. They possess a high level of species richness and endemism, particularly in amphibians, reptiles, and flowering plants.

3. Comparison:

While the Gangetic Plain and Thar Desert are important ecosystems, they do not meet the specific high-endemism and high-threat criteria required to be classified as international biodiversity hotspots.

Final Answer: The Western Ghats is a biodiversity hotspot in India.

Answer: (A)

Q69.

Solution

Concept:

Ecological pyramids represent the relationship between different trophic levels in terms of numbers, biomass, or energy.

The Pyramid of Energy specifically shows the total amount of energy present at each level of a food chain.

Solution:

1. The 10% Law:

According to Lindeman's 10% Law, only about 10% of the energy available at one trophic level is transferred to the next level. The rest is lost as heat.

2. Consequences for Shape:

Because energy is invariably lost at every transfer, the amount of energy available to a higher trophic level is always less than that of the level below it.

3. Conclusion:

This means the base (producers) is always the widest, and the pyramid tapers toward the top. Unlike pyramids of numbers or biomass, which can sometimes be inverted (e.g., in a parasitic food chain), the pyramid of energy can **never** be inverted. It is always upright.

Final Answer: The Pyramid of Energy is always Upright.

Answer: (A)

Q70.

Solution

Concept:

Air pollutants are classified into two categories based on how they are released into the environment.

- **Primary Pollutants:** Emitted directly from a source (e.g., a chimney or exhaust pipe).
- **Secondary Pollutants:** Formed in the atmosphere through chemical reactions between primary pollutants and other atmospheric components.

Solution:

1. Analysis of Carbon Monoxide (CO):

CO is produced directly from the incomplete combustion of fossil fuels in vehicles and industrial processes. Therefore, it is a primary pollutant.

2. Analysis of Other Options:

- Ozone (O_3) in the lower atmosphere is formed by reactions between nitrogen oxides and volatile organic compounds in the presence of sunlight; it is a secondary pollutant.
- PAN (Peroxyacetyl nitrate) is a component of photochemical smog formed by chemical reactions; it is a secondary pollutant.
- H_2SO_4 (Sulfuric acid) is formed when sulfur dioxide reacts with water vapor; it is a secondary pollutant.

Final Answer: CO is a primary pollutant.

Answer: (A)

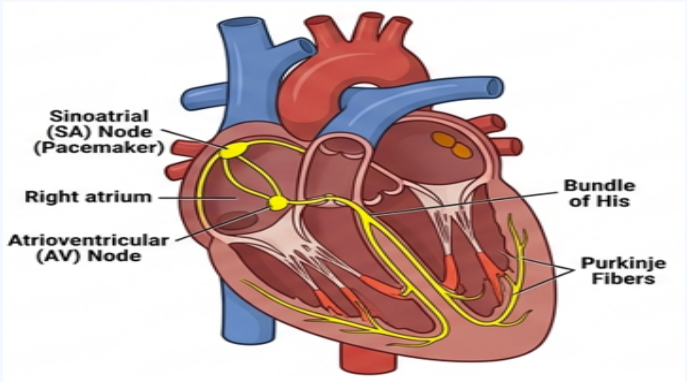
Q71.

Solution

Concept:

The human heart is a myogenic organ, meaning its rhythmic contractions are generated internally by specialized cardiac muscle fibers rather than external nerve impulses.

The "pacemaker" is the component that initiates the electrical impulse and sets the pace for the entire heart's contraction.



Solution:

1. Identification of the Pacemaker:

The Sino-atrial Node (SA Node) is the natural pacemaker of the heart.

2. Location:

It is located in the upper right corner of the right atrium.

3. Mechanism:

The SA node generates action potentials (electrical impulses) at a rate of 70-75 times per minute. These impulses spread through the atria, causing them to contract, and are then passed to the AV node.

4. Comparison:

The AV node (Atrioventricular node) is often called the "pace-setter" because it delays the impulse slightly to allow the ventricles to fill before contracting.

Final Answer: The SA Node is known as the pacemaker of the heart.

Answer: (A)

Q72.

Solution

Concept:

In addition to being a structural component of the human body, the skeletal system (specifically bone marrow) plays a critical role in the circulatory and immune systems through the process of hematopoiesis.

Solution:

1. Role of Bone Marrow:

In adults, the red bone marrow, found in the spongy parts of bones (like the ribs, vertebrae, and the ends of long bones), is the primary site for the production of all blood cells.

2. Cell Types Produced:

- Red Blood Cells (Erythrocytes) for oxygen transport.
- White Blood Cells (Leukocytes) for immune defense.
- Platelets (Thrombocytes) for blood clotting.

3. Conclusion:

The skeletal system provides the necessary microenvironment for stem cells to differentiate into mature blood cells.

Final Answer: Red Blood Cells (RBCs) are produced in the bone marrow.

Answer: (B)

Q73.

Solution

Concept:

Hormones are chemical messengers secreted by endocrine glands directly into the blood.

The Master Gland is the one that produces hormones that regulate the activity of many other endocrine glands in the body.

Solution:

1. Identification:

The Pituitary Gland is commonly referred to as the "Master Gland."

2. Location:

It is a small, pea-sized gland located at the base of the brain, attached to the hypothalamus by a stalk.

3. Regulatory Function:

It secretes hormones like TSH (which controls the thyroid), ACTH (which controls the adrenal cortex), and FSH/LH (which control the gonads).

4. Note on Hypothalamus:

While the pituitary is the "Master Gland," it is itself regulated by the hypothalamus, which acts as the "Master of the Master Gland."

Final Answer: The Pituitary Gland is the master gland.

Answer: (B)

Q74.

Solution

Concept:

Excretion is the process of removing metabolic waste products (like nitrogenous wastes) from the body.

Different animals have evolved different excretory organs depending on their environment and biological complexity.

Solution:

1. Excretory Organs in Cockroaches:

Cockroaches (and most insects) use specialized structures called Malpighian tubules for excretion.

2. Structure and Function:

These are yellow-colored, thin, filamentous tubules attached at the junction of the midgut and hindgut. They absorb nitrogenous wastes from the hemolymph (blood) and convert them into uric acid, which is then excreted into the intestine.

3. Other Examples:

- Nephridia are found in Earthworms.
- Flame cells (Protonephridia) are found in Flatworms (Platyhelminthes).
- Kidneys are found in Vertebrates.

Final Answer: Malpighian tubules are the excretory organs of the cockroach.

Answer: (B)

Q75.

Solution

Concept:

Bile is a digestive fluid produced by the liver and stored in the gallbladder.

Unlike most other digestive juices (like gastric or pancreatic juice), bile does not contain any digestive enzymes.

Solution:

1. Composition of Bile:

Bile consists of water, bile salts (like sodium glycocholate), bile pigments (bilirubin and biliverdin), cholesterol, and phospholipids.

2. Function in Digestion:

Even without enzymes, bile is essential for fat digestion. It performs "Emulsification," where it breaks down large fat globules into tiny droplets (micelles), significantly increasing the surface area for the enzyme lipase to act upon.

3. Activation:

Bile also provides an alkaline environment and activates the enzyme lipase.

4. Conclusion:

Therefore, bile aids in the chemical digestion of fats through physical breakdown and enzyme activation, rather than direct enzymatic catalysis.

Final Answer: Bile juice is responsible for the Emulsification of fats.

Answer: (A)

Q76.

Solution

Concept:

The human respiratory system is designed for the efficient exchange of gases between the atmosphere and the blood.

The process relies on a pressure gradient created by the contraction and relaxation of specific muscles.

Solution:

1. Primary Muscle of Respiration:

The diaphragm is a dome-shaped sheet of skeletal muscle that separates the thoracic cavity from the abdominal cavity.

2. Mechanism of Inspiration (Inhalation):

When the diaphragm contracts, it moves downward and flattens. This increases the volume of the thoracic cavity, lowering the internal air pressure and drawing air into the lungs.

3. Mechanism of Expiration (Exhalation):

When the diaphragm relaxes, it moves upward back into its dome shape. This decreases thoracic volume, increases internal pressure, and forces air out of the lungs.

4. Supporting Muscles:

The external intercostal muscles also assist by lifting the ribs and sternum.

Final Answer: The Diaphragm is the primary muscle responsible for breathing in humans.

Answer: (A)

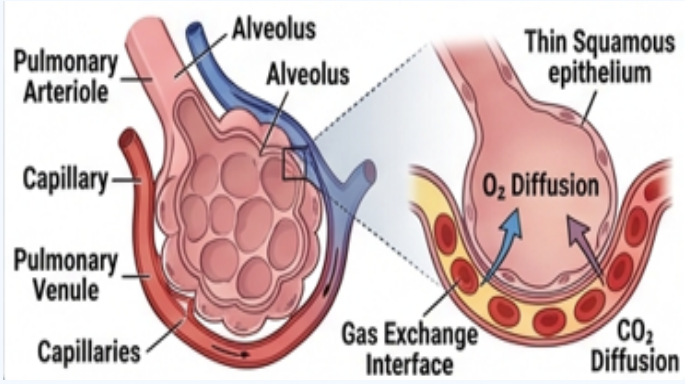
Q77.

Solution

Concept:

The exchange of gases (O_2 and CO_2) occurs at two main sites in the body: the lungs (external respiration) and the tissues (internal respiration).

This exchange happens via simple diffusion, driven by a concentration or pressure gradient.



Solution:

1. Structural Unit for Gas Exchange:

The Alveoli (singular: Alveolus) are tiny, balloon-like air sacs at the end of the bronchial tubes.

2. Adaptations for Diffusion:

- The alveolar wall is extremely thin (composed of a single layer of squamous epithelial cells).
- They are surrounded by a dense network of thin-walled pulmonary capillaries.
- The total surface area provided by millions of alveoli is massive (roughly the size of a tennis court).

3. Process:

Oxygen diffuses from the high-pressure environment of the alveoli into the blood, while carbon dioxide diffuses from the blood into the alveoli to be exhaled.

Final Answer: The Alveoli are the primary sites of gas exchange in the lungs.

Answer: (A)

Q78.

Solution

Concept:

Blood is a fluid connective tissue composed of plasma and formed elements.

Platelets, or thrombocytes, are small, colorless cell fragments in our blood that play a vital role in preventing excessive bleeding.

Solution:

1. Function of Platelets:

The primary role of platelets is Blood Coagulation (Clotting).

2. Mechanism:

When a blood vessel is injured, platelets rush to the site and stick to the edges of the wound. They release clotting factors (like thromboplastin) that initiate a cascade of chemical reactions.

3. Formation of the Clot:

This cascade leads to the conversion of soluble fibrinogen into insoluble fibrin threads, which trap blood cells to form a "plug" or clot, sealing the injury.

4. Comparison:

RBCs transport oxygen. WBCs defend against infections. Plasma transports nutrients and wastes.

Final Answer: Platelets are essential for Blood Clotting.

Answer: (B)

Q79.

Solution

Concept:

Synapses are the junctions where a nerve impulse is transmitted from one neuron to another. In most human synapses, the signal is transferred using specialized chemical messengers.

Solution:

1. Identification:

These chemicals are called Neurotransmitters.

2. Process of Transmission:

When an action potential reaches the axon terminal, it triggers the release of neurotransmitters from synaptic vesicles into the synaptic cleft (the gap between neurons).

3. Receptor Binding:

The neurotransmitters diffuse across the gap and bind to specific receptors on the dendrite of the next neuron, initiating a new electrical signal.

4. Examples:

Common neurotransmitters include Acetylcholine, Dopamine, and Serotonin.

5. Comparison:

Hormones are messengers of the endocrine system. Enzymes are biological catalysts.

Final Answer: Neurotransmitters are the chemicals that transmit signals across a synapse.

Answer: (C)

Q80.

Solution

Concept:

The human brain is the central information processing organ of the body.

It is divided into different regions, each responsible for specific functions like voluntary movement, sensory perception, and complex thought processes.

Solution:

1. Identification of the Cerebrum:

The cerebrum is the largest part of the human brain, making up about 80% of its weight.

2. Functions:

It is the seat of intelligence, memory, reasoning, and consciousness. It interprets sensory inputs (vision, hearing, touch) and initiates voluntary muscle contractions.

3. Structure:

It is divided into two cerebral hemispheres connected by the corpus callosum. The highly folded outer layer is called the cerebral cortex.

4. Comparison:

The Cerebellum controls balance. The Medulla controls involuntary actions (heartbeat/breathing). The Hypothalamus controls temperature and hunger.

Final Answer: The Cerebrum is responsible for memory, intelligence, and voluntary actions.

Answer: (A)

Q81.

Solution

Concept:

The nephron is the functional unit of the kidney, and its primary role is to filter blood to produce urine.

This process involves three main steps: glomerular filtration, tubular reabsorption, and tubular secretion.

Reabsorption is the process by which the body "takes back" useful substances from the filtrate into the bloodstream.

Solution:

1. Role of the Proximal Convoluted Tubule (PCT):

The PCT is the first segment of the renal tubule following Bowman's capsule.

2. Extent of Reabsorption:

Nearly all essential nutrients (100% of glucose and amino acids) and 70-80% of electrolytes and water are reabsorbed in this segment.

3. Structural Adaptation:

The PCT is lined by simple cuboidal brush border epithelium. The microvilli increase the surface area enormously to facilitate this massive reabsorption.

4. Comparison:

The Loop of Henle is mainly for water and salt balance. The DCT and Collecting Duct perform conditional reabsorption under hormonal control.

Final Answer: The majority of reabsorption of water and electrolytes occurs in the Proximal Convoluted Tubule (PCT).

Answer: (A)

Q82.

Solution

Concept:

The human endocrine system includes several glands that secrete hormones.

One gland is unique because it is very large in infants and children but gradually shrinks (atrophies) after puberty, being replaced by fat.

Solution:

1. Identification:

The Thymus gland is located in the upper chest, behind the sternum and between the lungs.

2. Function:

It is a primary lymphoid organ where T-lymphocytes (T-cells) mature. It secretes the hormone thymosin, which plays a major role in the development of the immune system.

3. Age-Related Change:

The thymus reaches its maximum absolute size at puberty. As a person ages, the thymus undergoes involution, which is why elderly individuals often have a weakened immune response.

4. Comparison:

The Thyroid, Adrenal, and Pancreas glands remain functional and maintain their relative size throughout adulthood.

Final Answer: The Thymus gland decreases in size with age.

Answer: (C)

Q83.

Solution

Concept:

Blood pressure is the force exerted by circulating blood against the walls of the body's arteries. It is measured using two values: Systolic (pressure during heart contraction) and Diastolic (pressure during heart relaxation).

Solution:

1. Normal Range:

The standard healthy blood pressure for a resting adult is 120/80 mmHg.

2. Definition of Hypertension:

Hypertension, or high blood pressure, occurs when blood pressure is consistently higher than normal.

3. Clinical Threshold:

Medical guidelines generally define hypertension as a persistent reading of 140/90 mmHg or higher.

4. Significance:

Chronic hypertension can lead to serious health complications, including heart disease, stroke, and kidney failure.

Final Answer: A blood pressure reading of 140/90 mmHg or higher is considered hypertension.

Answer: (C)

Q84.

Solution

Concept:

In the human body, joints are the points where two or more bones meet.

They are classified based on the degree of movement they allow.

Synovial joints are characterized by a fluid-filled cavity that allows for considerable movement.

Solution:

1. Hinge Joint:

A hinge joint allows movement primarily in one plane (like a door hinge), facilitating bending and straightening.

2. Examples:

The knee joint and the elbow joint are the most prominent examples of hinge joints in the human body.

3. Other Joint Types:

- Ball and Socket joint (Shoulder/Hip): Allows multi-directional movement.
- Pivot joint (Neck): Allows rotation.
- Gliding joint (Wrist/Ankle): Allows bones to slide over one another.

Final Answer: The Knee joint is an example of a Hinge joint.

Answer: (B)

Q85.

Solution

Concept:

Human blood is classified into different groups based on the presence or absence of specific antigens (proteins) on the surface of the red blood cells.

The most important system is the ABO blood group system.

Solution:

1. Identification of the Universal Donor:

Blood group O (specifically O negative) is known as the universal donor.

2. Why O is the Donor:

Red blood cells of group O have no A or B antigens on their surface. Therefore, when this blood is transfused into a recipient of any other group, the recipient's immune system will not recognize the cells as "foreign" and will not attack them.

3. Identification of the Universal Recipient:

Blood group AB is the universal recipient because these individuals have both A and B antigens and do not produce anti-A or anti-B antibodies.

4. Conclusion:

Group O can be given to patients with A, B, AB, or O blood types in emergencies.

Final Answer: Blood group O is considered the universal donor.

Answer: (C)

Q86.

Solution

Concept:

The human respiratory system is protected by a double-layered membrane. This structure reduces friction between the lungs and the chest wall during the continuous expansion and contraction of the breathing cycle.

Solution:

1. Identification:

The lungs are enclosed by a double-layered serous membrane called the Pleura.

2. Layers:

- The outer layer, called the parietal pleura, is attached to the chest wall.
- The inner layer, the visceral pleura, covers the surface of the lungs.

3. Pleural Fluid:

The narrow space between these two layers is called the pleural cavity, which contains pleural fluid. This fluid acts as a lubricant, allowing the lungs to glide smoothly against the rib cage.

4. Comparison:

The Pericardium surrounds the heart. The Peritoneum lines the abdominal cavity. The Meninges protect the brain and spinal cord.

Final Answer: The Pleura is the membrane that covers the lungs.

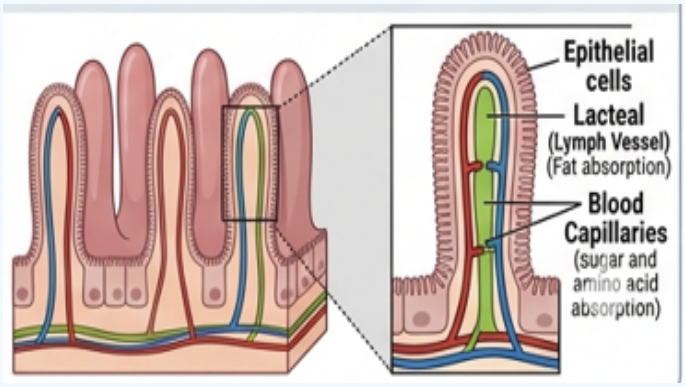
Answer: (C)

Q87.

Solution

Concept:

The small intestine is the primary site for the final digestion of food and the absorption of nutrients. Its internal structure is highly modified to maximize the efficiency of this process.



Solution:

1. Structural Adaptation:

The inner wall of the small intestine is covered with millions of tiny, finger-like projections called Villi.

2. Function:

The primary purpose of villi is to increase the surface area for absorption. Each villus also contains even smaller projections called microvilli (brush border), further expanding the area.

3. Nutrient Transport:

Each villus contains a network of blood capillaries to absorb sugars and amino acids, and a central lymph vessel called a lacteal to absorb fatty acids and glycerol.

4. Comparison:

Alveoli are for gas exchange. Nephrons are for filtration in the kidney.

Final Answer: Villi are finger-like projections that increase surface area for absorption.

Answer: (B)

Q88.

Solution

Concept:

Muscle contraction is a chemical process that requires energy and specific ions. The "Sliding Filament Theory" explains how muscle fibers shorten.

Solution:

1. Role of Calcium (Ca^{2+}):

Calcium ions are stored in the sarcoplasmic reticulum. When a nerve impulse arrives, Ca^{2+} is released into the sarcoplasm, where it binds to troponin to initiate contraction.

2. Role of ATP (Adenosine Triphosphate):

ATP is the immediate source of energy for muscle contraction. It is required for the "power stroke" (where myosin pulls actin) and for the detachment of the myosin head from the actin filament so the cycle can repeat.

3. Fatigue:

In the absence of sufficient ATP, muscles cannot relax, leading to muscle cramps or rigor.

Final Answer: Both Calcium ions and ATP are required for muscle contraction.

Answer: (C)

Q89.

Solution

Concept:

Excretory products in the animal kingdom vary based on habitat and water availability. The three main nitrogenous wastes are ammonia, urea, and uric acid.

Solution:

1. Uricotelic Animals:

Animals that excrete nitrogenous waste primarily in the form of Uric Acid are called uricotelic.

2. Advantage of Uric Acid:

Uric acid is the least toxic and requires the minimum amount of water for its elimination. It is usually excreted as a paste or pellet, which is an essential adaptation for water conservation.

3. Examples:

Birds, reptiles, and land snails are typical uricotelic animals.

4. Comparison:

Mammals are ureotelic (excrete urea). Aquatic animals like fish are ammonotelic (excrete ammonia).

Final Answer: Birds excrete nitrogenous waste in the form of Uric Acid.

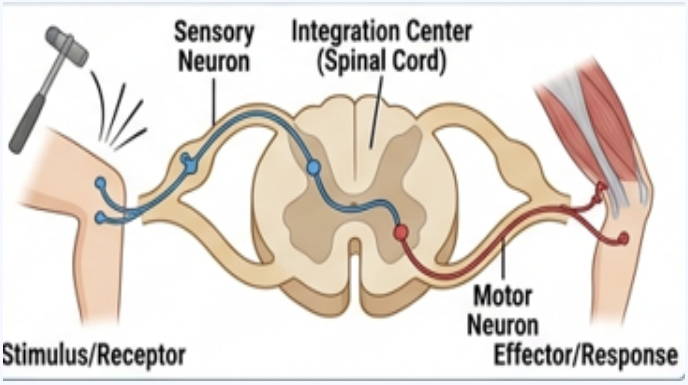
Answer: (C)

Q90.

Solution

Concept:

Reflex actions are sudden, involuntary responses to a stimulus that occur without conscious thought. These actions are managed by a specific neural pathway.



Solution:

1. The Reflex Arc:

A reflex arc consists of a receptor, a sensory neuron, an integration center, a motor neuron, and an effector (muscle or gland).

2. Role of the Spinal Cord:

In most spinal reflexes (like pulling your hand away from a hot stove), the integration happens in the spinal cord rather than the brain. This allows for an extremely fast response to prevent injury.

3. Process:

The sensory signal enters the spinal cord, is processed by an interneuron, and an immediate motor command is sent back to the muscle. The brain only becomes "aware" of the event after the action has already occurred.

Final Answer: Reflex actions are primarily controlled by the Spinal Cord.

Answer: (B)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	A	4	B	5	B
6	C	7	A	8	B	9	B	10	C
11	C	12	C	13	B	14	A	15	C
16	C	17	A	18	C	19	C	20	B
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81	A	82	C	83	C	84	B	85	C
86	C	87	B	88	C	89	C	90	B